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EVALUATING PAEDIATRIC ANTIBIOTIC USE: PREVALENCE OF DRUG-DRUG INTERACTIONS AND THE NEED FOR ANTIMICROBIAL STEWARDSHIP

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Abstract

Background: Antimicrobial resistance (AMR) is a growing global health crisis, with paediatric populations particularly vulnerable to inappropriate antibiotic use. This study aimed to evaluate antibiotic prescribing patterns, the prevalence of drug-drug interactions (DDIs), and the extent of microbiological testing among paediatric inpatients.

Methods: A prospective observational study was conducted over six months in the paediatric department of Varun Arjun Medical College & Rohilkhand Hospital. A total of 150 paediatric inpatients receiving antibiotic therapy were included. Data on demographics, infection type, prescribed antibiotics, dosage forms, DDIs, and antibiotic sensitivity testing were collected and analyzed. Descriptive statistics were used to assess prescribing patterns and interactions.

Results: Among the 150 enrolled patients, males (56.00%) were more predominant than females (44.00%). The majority (55.33%) were aged 1-11 years. Respiratory tract infections (RTIs) (33.00%) were the most common indication for antibiotic therapy, followed by gastrointestinal infections (24.66%). Ceftriaxone (24.66%) was the most frequently prescribed antibiotic. Injectable formulations (91.30%) were preferred over oral formulations. A total of 26.70% subjects were found to have drug-drug interactions (DDIs). Only 6.70% of patients underwent antibiotic sensitivity testing, highlighting a gap in microbiological confirmation before antibiotic initiation.

Discussion: The findings emphasize the overuse of broad-spectrum antibiotics and the low rate of microbiological testing in paediatric patients, raising concerns about AMR. The high prevalence of DDIs underscores the need for enhanced pharmacovigilance and integration of electronic prescribing systems to monitor interactions. The lack of institutional guidelines for paediatric antibiotic use contributes to inconsistent prescribing patterns, necessitating implementing antimicrobial stewardship programs (ASPs) to optimize antibiotic selection and minimize resistance risks.

Conclusion: This study underscores the need for standardized institutional guidelines and antimicrobial stewardship programs to ensure judicious antibiotic use in paediatric inpatients. Enhancing microbiological testing, implementing electronic prescribing systems, and promoting transition from injectable to oral therapy can significantly improve antibiotic prescribing practices and reduce AMR risk.

Keywords: Antibiotic resistance, Paediatric infections, Drug-drug interactions, Antimicrobial stewardship, Ceftriaxone, Antibiotic prescribing patterns.

Introduction

Antimicrobial resistance (AMR) has emerged as a global public health crisis, posing a significant threat to effective infection management and increasing morbidity and mortality rates worldwide. The World Health Organization (WHO) has identified AMR as one of the top ten global health threats, emphasising the urgent need for strategies to combat its rapid spread [1]. The misuse and overuse of antibiotics in clinical practice, particularly in paediatric populations, contribute to the development of resistant bacterial strains, leading to prolonged hospital stays, increased healthcare costs, and higher mortality rates [2][3]. By 2050, antimicrobial resistance is projected to cause approximately 10 million deaths annually, with 4.7 million deaths anticipated in Asia alone [4].

Paediatric patients are highly susceptible to infections due to their underdeveloped immune systems, making appropriate antibiotic use crucial in this population. However, studies have highlighted irrational prescribing practices, including the use of broad-spectrum antibiotics without culture sensitivity testing, as key drivers of AMR in paediatric settings [5][6]. Among hospitalized children, respiratory tract infections (RTIs) remain one of the most common indications for antibiotic therapy, with cephalosporins such as ceftriaxone frequently prescribed [7]. Despite established guidelines advocating for judicious antibiotic use, many paediatric patients receive empirical antibiotic therapy without microbiological confirmation [8].

Antibiotic stewardship programs (ASPs) have been introduced to optimize antibiotic use and minimize AMR by promoting evidence-based prescribing and monitoring drug-drug interactions (DDIs) [9]. Previous studies have reported high incidences of DDIs in hospitalized paediatric patients, where antibiotics interact with other medications, potentially compromising therapeutic outcomes and increasing adverse drug reactions [10][11]. Implementing institutional guidelines for diagnosing and treating common infections is critical in reducing unnecessary antibiotic exposure and mitigating the risk of resistance [12].

The rationale for this study stems from the urgent need to assess antibiotic prescribing patterns, identify common infections requiring antibiotic therapy, and evaluate the prevalence of DDIs in paediatric patients. Despite global efforts to curtail AMR, data on paediatric antibiotic use and its implications for resistance remain limited in many regions, necessitating further investigation. This study aims to analyze antibiotic consumption patterns, assess the frequency of antibiotic-related DDIs, and evaluate adherence to antimicrobial stewardship principles in paediatric inpatients. By identifying gaps in prescribing practices, the findings can contribute to developing targeted interventions to minimise AMR risks in paediatric healthcare settings.

Materials and Methods

This prospective observational study was conducted over a six-month period from July 2023 to December 2023 in the paediatric department of Varun Arjun Medical College & Rohilkhand hospital to assess antibiotic prescribing patterns, drug-drug interactions (DDIs), and microbiological testing practices. The study included 150 paediatric inpatients receiving antibiotic therapy. Patients with co-morbid conditions were also included, while those receiving antibiotics for prophylactic purposes or with incomplete medical records were excluded. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was obtained from the guardians of all participants.

Data was collected through a structured case report form (CRF), which documented demographic details, infection type, prescribed antibiotics, dosage forms, and the presence of DDIs. The antibiotics were identified using their generic names, and their doses were recorded in mg/kg body weight. Drug interactions were assessed using Micromedex Drug Interaction Checker and classified based on clinical significance. Microbiological data, including culture and antibiotic sensitivity test results, were collected from laboratory records.

The study drugs were prescribed by paediatricians based on clinical judgment, with ceftriaxone being the most commonly used intravenous antibiotic. Other antibiotics, including amoxicillin, azithromycin, cefotaxime, and ciprofloxacin, were also prescribed as monotherapy or combined. The route of administration included intravenous (i.v.) and oral (p.o.) formulations, with injectables being predominant.

All data were entered and analysed using Microsoft Excel 2021. Descriptive statistics, including frequency distributions and percentages, were used to summarise categorical data. Given the observational nature of the study, no interventions were performed, and treatment decisions were solely based on the hospital's existing protocols. Limitations, such as reliance on hospital records and the lack of long-term follow-up, were acknowledged. The study adhered to the ethical principles of the Declaration of Helsinki, ensuring confidentiality and data security.

Results

The demographic and clinical characteristics of the study participants reveal a higher representation of males compared to females. The majority of participants belong to the early childhood age group, followed by adolescents, with infants comprising the most minor proportion. These findings highlight the predominance of younger children in the study population, suggesting a greater clinical relevance for this age group (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants

Characteristic	Frequency (n=150)	Percentage (%)
Gender		
Male	84	56.00
Female	66	44.00
Age Group		
<1 year	22	14.66
1-11 years	83	55.33
12-18 years	45	30.00

The most common infections observed among the study population were respiratory tract infections (33.33%), followed by gastrointestinal infections (24.70%) (Table 2).

Table 2: Distribution of Infections Among Study Participants

Type of Infection	Frequency (n=150)	Percentage (%)
Respiratory Tract Infection	50	33.33
Gastrointestinal Infection	37	24.66
Urinary Tract Infection	22	14.66
Skin and Soft Tissue Infection	18	12.00
Other	23	15.33

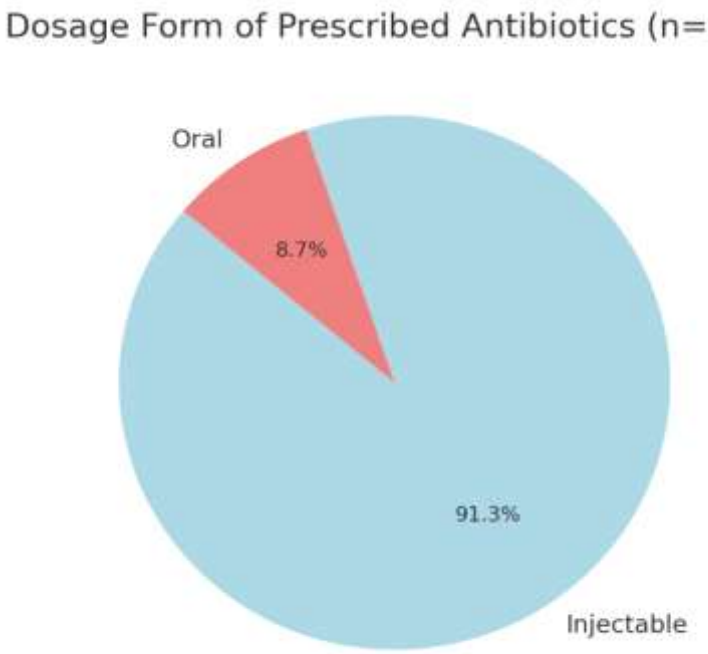
Ceftriaxone was the most commonly prescribed antibiotic (24.6%), followed by amoxicillin (20.3%) and azithromycin (18.0%) (Table 3).

Table 3: Distribution of Prescribed Antibiotics

Antibiotic	Frequency (n=150)	Percentage (%)
Ceftriaxone	37	24.66
Amoxicillin	31	20.66
Azithromycin	27	18.00
Cefotaxime	21	14.00
Ciprofloxacin	19	12.66
Others	15	10.00

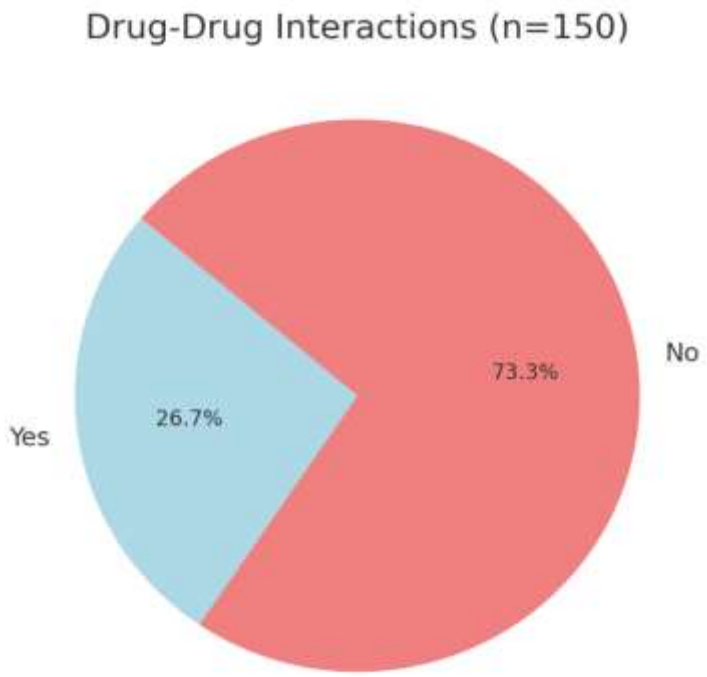
Injectable formulations were the predominant dosage form (91.30%) compared to oral formulations (8.70%) (Figure 4).

Figure 4: Dosage Form of Prescribed Antibiotics



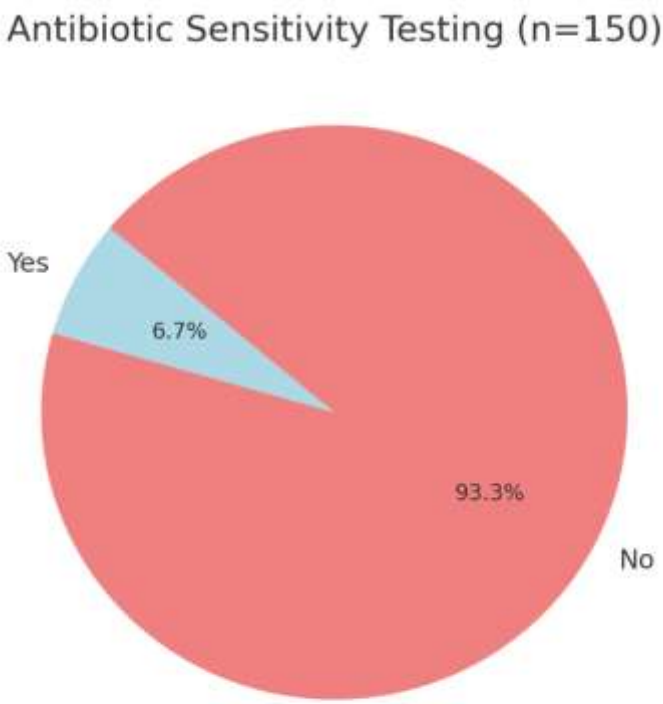
A total of 26.70% of subjects were found to have drug-drug interactions, while 73.30% had no reported drug-drug interactions (Figure 5).

Figure 5: Drug-Drug Interactions



Only 6.70% of the participants underwent antibiotic sensitivity testing, while the majority (93.3%) did not undergo such testing (Figure 6).

Figure 6: Antibiotic Sensitivity Testing



Discussion

The findings of this study highlight a high prevalence of respiratory tract infections (RTIs) (33%) among hospitalized paediatric patients, aligning with global trends where RTIs remain the leading cause of antibiotic prescriptions in children. The predominance of ceftriaxone (24.64%) as the most frequently prescribed antibiotic reflects its broad-spectrum activity and widespread use in paediatric infections. However, reliance on broad-spectrum antibiotics without routine microbiological confirmation could contribute to the escalation of antimicrobial resistance (AMR). This study observed that only 6.66% of patients underwent antibiotic sensitivity testing, suggesting a need for enhanced microbiological surveillance before empirical antibiotic initiation.

While injectable formulations accounted for 91.39% of prescriptions, this high proportion is likely due to the severity of infections requiring hospitalization and the perceived efficacy of parenteral administration. However, study by Van den Anker JN (2021) suggest that early de-escalation to oral therapy, where appropriate, can reduce hospital stays, lower costs, and minimize complications associated with intravenous therapy [13]. The study underscores the necessity for evidence-based guidelines on transitioning from injectable to oral antibiotics in paediatric settings.

The study identified 40 drug-drug interactions (DDIs), with 80% involving antibiotics interacting with other drugs. Given the vulnerability of paediatric patients, these interactions could negatively impact therapeutic outcomes, leading to suboptimal responses or increased adverse effects. Paediatric patients often receive concurrent medications for comorbid conditions, necessitating enhanced pharmacovigilance and real-time monitoring of potential DDIs.

Antimicrobial stewardship programs (ASPs) are essential in promoting rational antibiotic use and reducing AMR. However, the lack of institutional guidelines for paediatric antibiotic use in many hospitals contributes to inconsistent prescribing practices. Strengthening ASPs through regular

prescription audits, physician education, and computerized decision-support systems could optimize antibiotic selection, dosing, and duration, reducing unnecessary antibiotic exposure.

Previous studies of Versporten A (2016) & Hsia Y (2019) have reported similar trends in paediatric antibiotic use, with third-generation cephalosporins being the most prescribed antibiotics in hospitalized children [14][15]. However, unlike study by McMullan BJ (2016) , this study specifically highlights the low rate of antibiotic sensitivity testing, indicating a significant gap in microbiological confirmation of infections before antibiotic initiation. Studies from high-income countries emphasize the role of routine culture sensitivity tests in reducing inappropriate prescribing and improving treatment outcomes [16].

Additionally, while this study identified a significant proportion of drug interactions, a systematic review by Smith MJ (2015) has found that clinically significant DDIs in paediatric patients often go unnoticed due to limited reporting mechanisms and absence of automated interaction checks in many healthcare settings [17]. These findings stress the need for electronic prescribing systems integrated with drug interaction alerts to improve safety in paediatric antibiotic use.

This study has certain limitations. Firstly, the study was conducted in a single-center setting, which may limit the generalizability of findings to other paediatric populations with different prescribing patterns. Secondly, the study relied on hospital records for data collection, which may introduce reporting biases or missing information regarding clinical decision-making for antibiotic prescriptions. Additionally, microbiological data were insufficient due to the low rate of culture sensitivity testing, making it challenging to determine whether prescribed antibiotics were truly appropriate for the isolated pathogens.

Another potential limitation is the short study duration (6 months), which may not capture seasonal variations in antibiotic use and resistance patterns. Future research should consider multi-center studies with longer follow-up periods to provide more comprehensive insights into paediatric antibiotic prescribing trends and resistance patterns.

To address the challenges identified in this study, several key recommendations should be implemented. Mandatory microbiological testing should be prioritized to increase the use of culture sensitivity tests before prescribing antibiotics, ensuring targeted therapy and reducing empirical overuse. By integrating routine laboratory testing, clinicians can make informed decisions based on microbial resistance patterns, thereby improving patient outcomes and minimizing unnecessary antibiotic exposure. Additionally, paediatric antibiotic stewardship programs (ASPs) should be implemented in hospitals to promote evidence-based prescribing, regular prescription audits, and physician training. These programs can help regulate antibiotic use, reduce antimicrobial resistance (AMR), and enhance patient safety by establishing standardized treatment protocols for paediatric infections.

Another crucial intervention is the integration of digital tools for drug interaction monitoring. Implementing electronic prescription systems with built-in drug interaction alerts can significantly improve the safety of antibiotic use in paediatric patients by minimizing the risk of adverse drug reactions (ADRs). Such systems can flag potential drug-drug interactions (DDIs) in real-time, enabling healthcare providers to make necessary adjustments before administration. Furthermore, transitioning to oral therapy where feasible should be emphasized in clinical guidelines. Early switch therapy from injectable to oral antibiotics can help reduce hospitalization costs, treatment-related complications, and patient discomfort while maintaining clinical efficacy. Promoting the use of oral formulations for mild to moderate infections can also contribute to better antimicrobial stewardship, ensuring that parenteral antibiotics are reserved for severe cases where intravenous administration is essential. By implementing these strategies, hospitals can optimize antibiotic prescribing practices, mitigate the risk of antimicrobial resistance, and improve overall paediatric patient care.

Conclusion

This study highlights the widespread use of broad-spectrum antibiotics, high prevalence of RTIs, and significant drug-drug interactions among paediatric inpatients. The low rate of microbiological testing

suggests an urgent need for institutional guidelines promoting rational antibiotic use. Strengthening antimicrobial stewardship programs, integrating electronic prescription systems, and ensuring microbiological confirmation of infections can significantly improve paediatric antibiotic prescribing practices and curb the growing threat of antimicrobial resistance.

Conflicts of Interest

The authors declare no conflicts of interest in relation to this study.

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